Dydaktyki fizyki

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MULTIMEDIA VS MICROCOMUTER BASED LABORATORY METHODS AND TOOLS IN SCIENCE EDUCATION

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Introduction

The role of media in our time is especially large. The second half of 20th century is often called "**Media Era**".

Multimedia assist people during the free time, are the main source of social information and communication, but also are a good tool of learning and intellectual work of mankind.

Let's remind the saying: "**Who has an information, has an authority**". It means that media are 4th kind of authority besides of legislative, executive and judgment authorities.

Short history

- For the first time visual media for teaching have been introduced by J.A. Komenski in the book "Orbis sensualium pictus (1658).

- In the USA the guide for teachers: "How to use slides in school teaching" has been edited (1906).

- In 1950-60 the programming teaching has been developed by Skinner, but in Poland only "technical teaching aids" were introduced.

- In Germany "media pedagogics" started to play an important role in home and school education.

But now: We are living in the **Information Society**, in which people use the information tools mostly for communication and international integration. Thus, all societies have to have easy and fast access to the contemporary media (multimedia) to receive and create information.

In 1999 the international project "E-Europe" has been founded aiming at:

- Computer Literacy
- Easy and cheap access to the Internet
- On – line governments
- The use of Internet in economy.

Functions of media

positive	negative
make easy and fast communication of information	can make manipulation of information (disinformation)
allow to make diagnosis and to advise (expert system)	diminish activity and creativeness (by lowering the knowledge)
stimulate people development by the use of constructionism idea	can show the criminal actions
promote positive system of values	create bad interpersonal relations and develop agresiveness
develop appropriate believes and attitudes of people (especially children and youths))	can cause the waste of time and health (computer spam, computer fobia, to be depended on Internet, etc.

Actual situation

Together with Colleagues from Finland, Scotland, Spain and Slovakia we are actually working on the SOCRATES COMENIUS 2.1 Project EU-ISE (Effective Use of ICT in Science Education).

International SOCRATES Cominius Project: (EU ISE)

Initiation

The initiators of EU ISE Project at the meeting in Kopenhaga
(from the left: Peter Demkanin, Jozefa Guitart,
Bob Kibble, Jari Lavonen, Jozefina Turlo)

The Project's rationale

- According to an OECD (2004) survey, the use of ICT in education in most countries concentrates on sporadic and mechanical information retrieval from the Internet.

- Therefore, the main goal of project EU ISE is to collect the best practices on the integration of ICT into science education, that can also motivate students and teachers and improve the quality of science teaching and learning.

- These best practices can demonstrate how ICT use can make science education more versatile and goal-oriented, inspire students active and creative self-learning, promote co-operation and study in authentic contexts.

- Objectives:
  1. To identify the best practice of using different methods and tools of ICT in science education across Europe, propose system for benchmarking this area,
  2. designed and test a course for in-service and pre-service teacher training in such way.

- **Target Groups:** Teachers of science in schools age 10-18 and trainee teachers of science. Lecturers with responsibility for in-service and pre-service teachers training

- **Main activities:**

1. Identification of the bet practices (based on literature and the examples of the effective use of ICT in school).
2. Creation of a training module for teachers.
3. Organisation of the international workshop for teacher trainers on EU-ISE.

The first activity

International Questionnaire for teachers: „Making the use of ICT in science teaching" (http://www.fizyka.umk.pl/test/data.php) have been performed

Until now the Polish partner collected about 117 answers (73% from women and 27% from men, among them more than 50% of physics secondary school teachers)

The teachers had a rather long school practice (80% of them 6-25 years and high qualification (as nominated and certificated teacher)

We got some answer to the questions: when, for what and in which way the ICT methods and tools are used by them in science education.

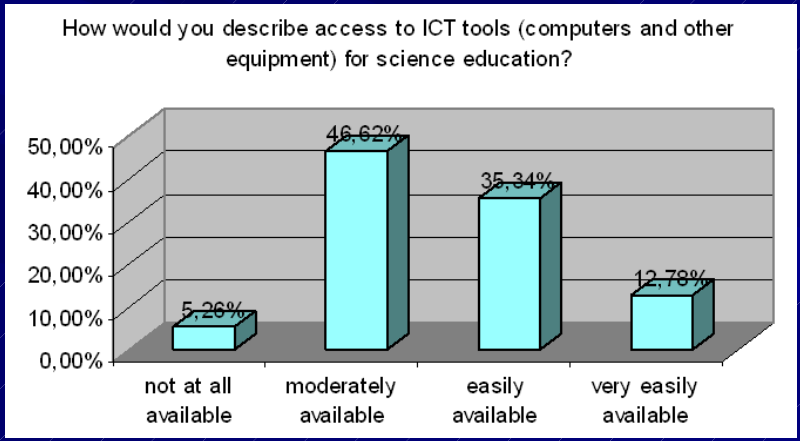
We have performed questionnaire investigations in Poland and results for our science are shown below:

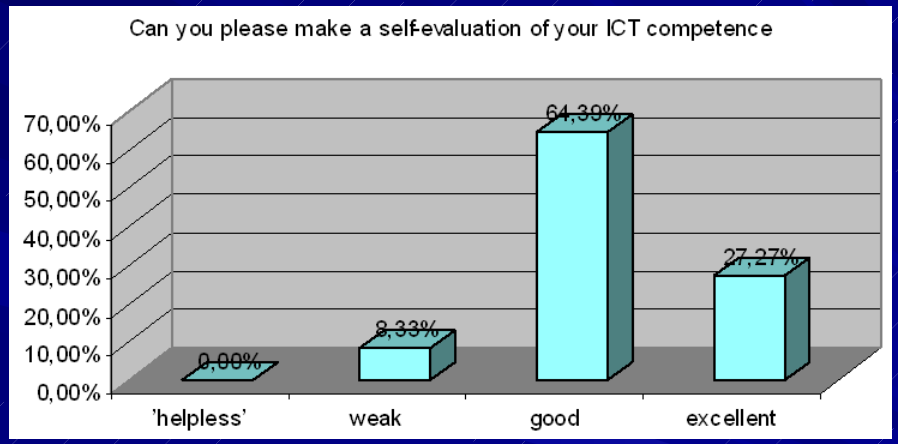
EU-ISE International Questionnaire for teachers

Making the use of ICT in science teaching

Results of Poland

They generally had good access to the computers and evaluating ICT competencies also as good. More than 50% are using computers at home.





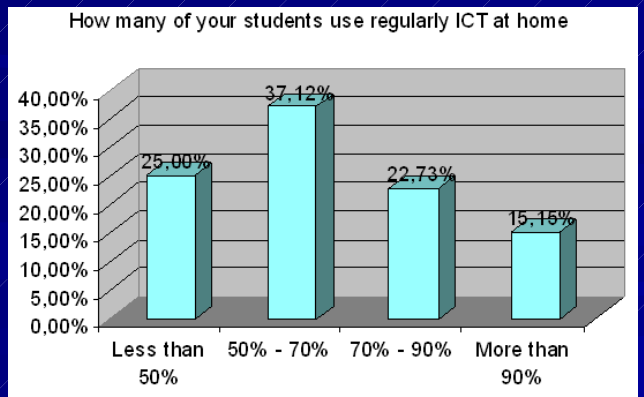


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Table 1. The views of teachers on ICT role in science education (24 questions)

		Strongly agree			Strongly disagree
1	ICT can have a positive effect on learning in science	95	31	3	5
2	The positive effect of ICT on learning in science is overestimated	7	19	31	65
3	More ICT resources in schools will result in better learning	59	66	3	7
4	I don't have time to make use of ICT resources in my teaching	7	22	44	56
5	I have skills to make good use of ICT in my teaching	66	49	9	7
6	ICT has radically changed the way I teach science	24	61	28	8
7	ICT is of particular benefit to slow learners	26	73	28	5
8	ICT is of particular benefit to fast learners	48	63	17	5
9	ICT is of particular benefit to independent learners	76	39	9	6
10	ICT is of particular benefit in assessment of learning	31	64	28	9
11	ICT is of particular benefit to make science learning more interesting	85	37	8	4
12	ICT can increase collaboration (co-operation) between students	64	56	8	4

Table 1. The views of teachers on ICT role in science education (24 questions)

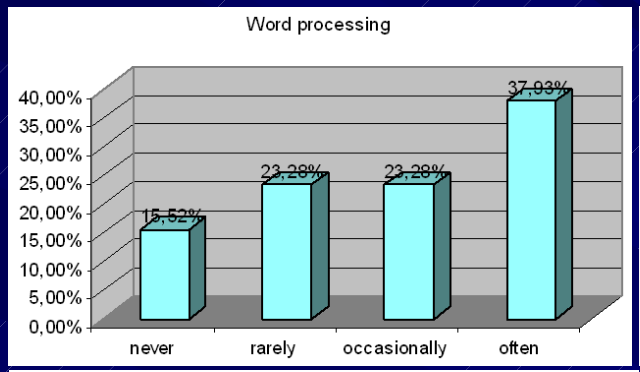
13	ICT makes learning more contextual	47	58	19	6
14	ICT makes learning more constructive (students are actively taking part to the learning process)	63	58	6	5
15	ICT makes learning more goal-oriented	36	81	12	3
16	ICT makes learning more active (students are active in planning and learning)	48	73	6	3
17	ICT makes learning more situated	39	64	23	4
18	ICT helps students in their self evaluation	35	64	24	9
19	ICT disturbs the learning process	8	6	15	102
20	ICT makes learning more research-oriented	41	63	17	6
21	ICT encourages students to study also printed materials	37	43	37	13
22	ICT helps teachers to deliver the school curriculum	44	64	18	7
23	I am persuading the school management to buy me more ICT equipment for teaching	63	45	14	8
24	School management expects me to use ICT in my teaching	31	44	33	23

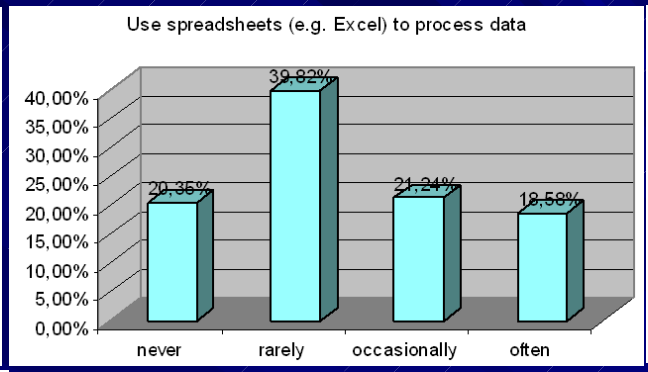
Table 2. Computer facilities in the classroom (9 questions)

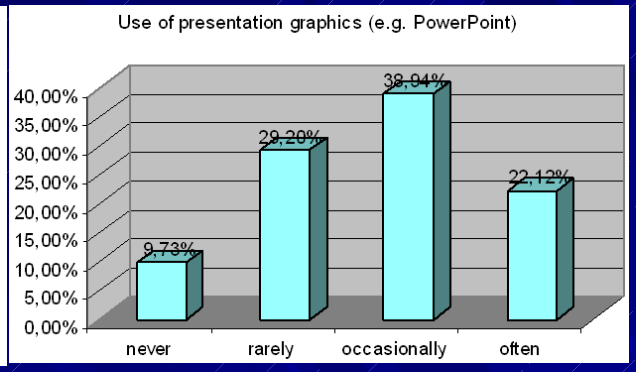
In a typical classroom you have available or access to:

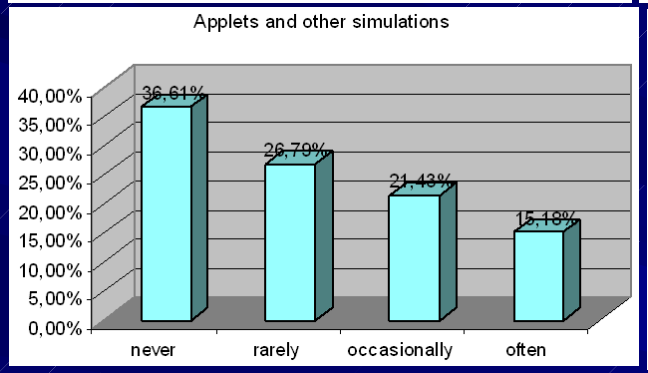
		Never			Always
1	One or some computers (less than one per 4 students)	44	15	28	42
2	Almost enough computers (more than one per 4 students)	62	21	23	22
3	Internet connection	28	11	23	72
4	Some MBL (data logging) tools and sensors	65	16	20	26
5	Enough MBL (data logging) tools and sensors	81	20	22	6
6	Interactive whiteboard	118	7	5	1
7	Digital camera	83	21	13	13
8	Digital microscope	118	6	2	4
9	Dataprojector or large enough screen	33	19	36	43

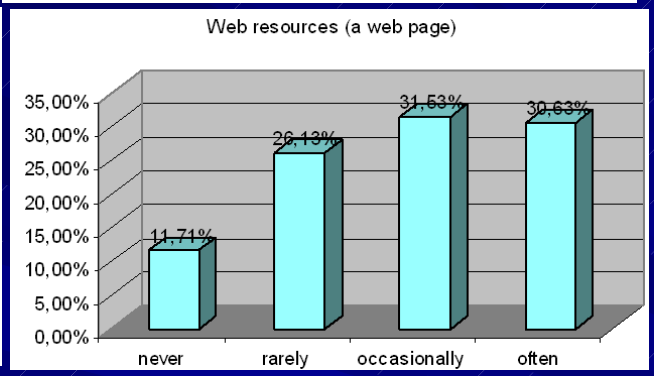
How often do you use ICT as a part of your science teaching?

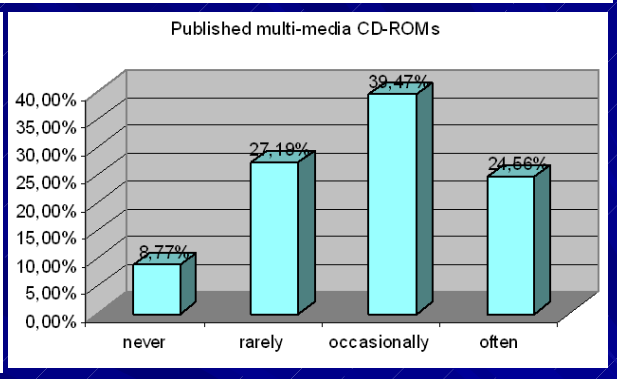


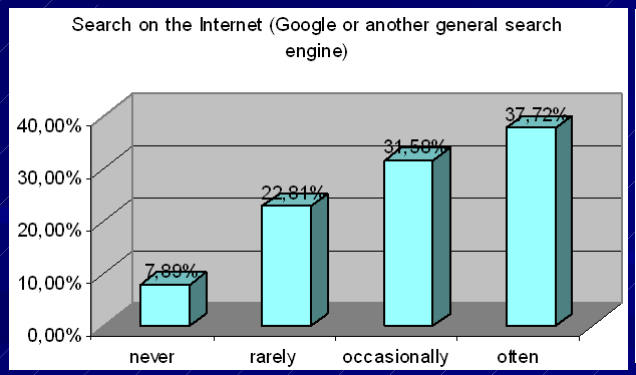


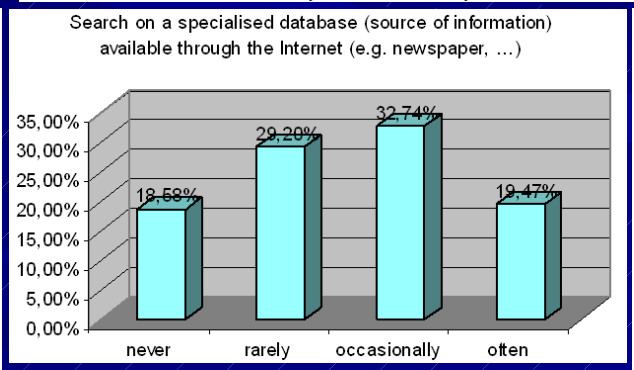


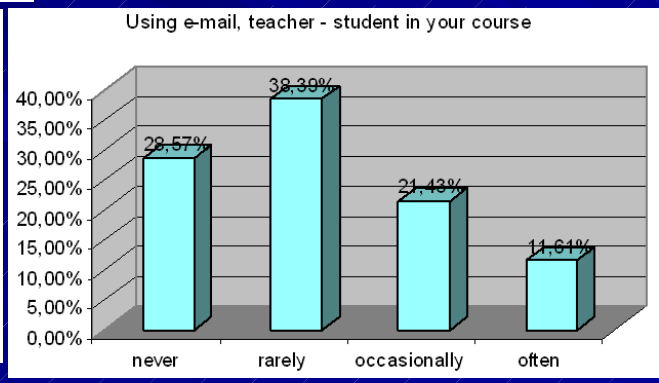












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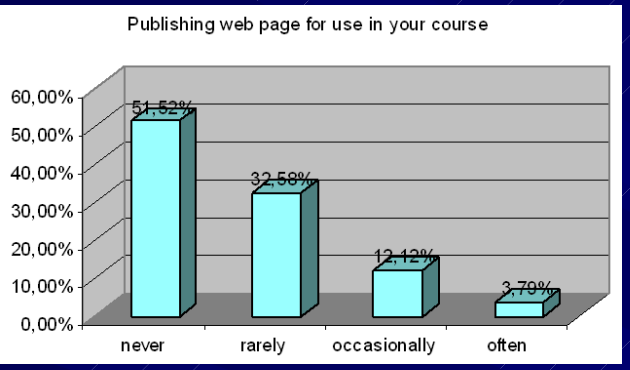

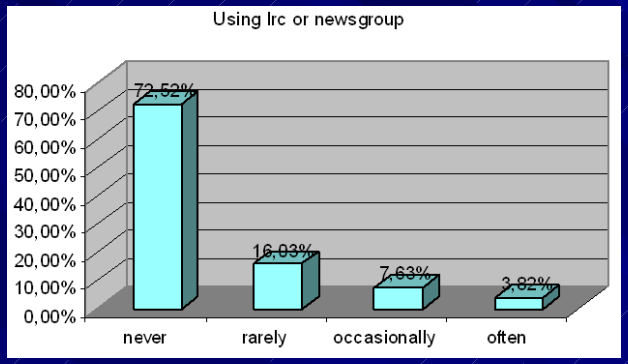

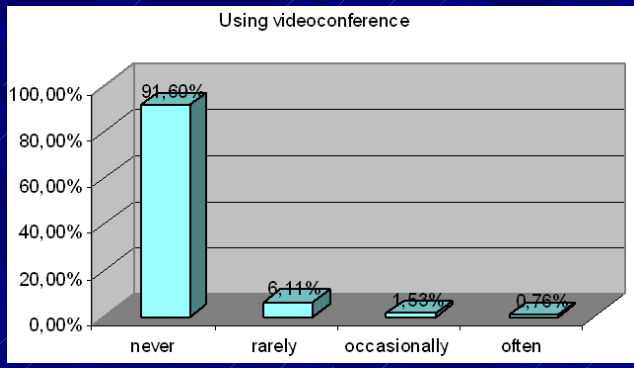

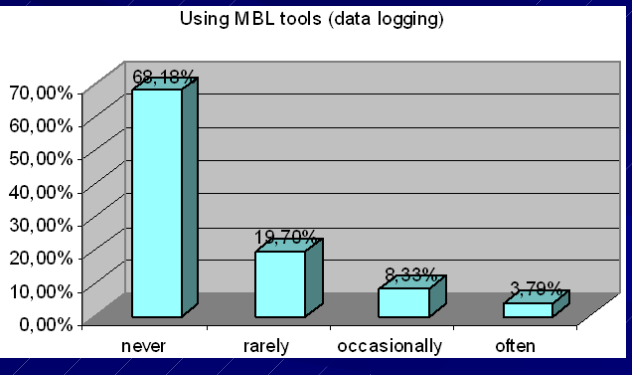

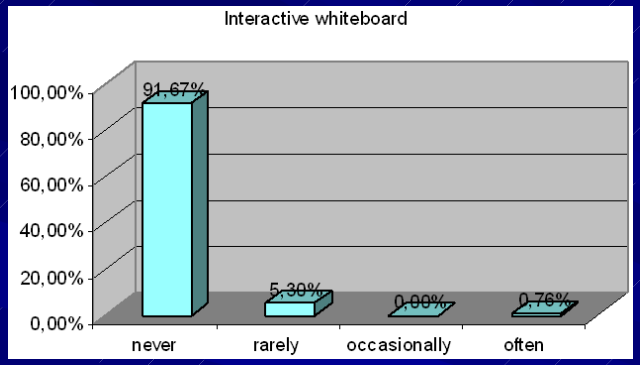

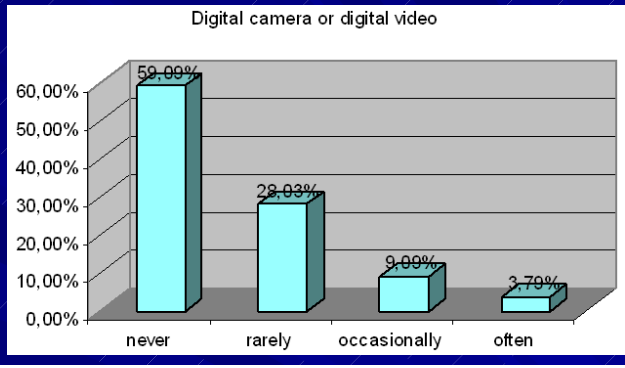

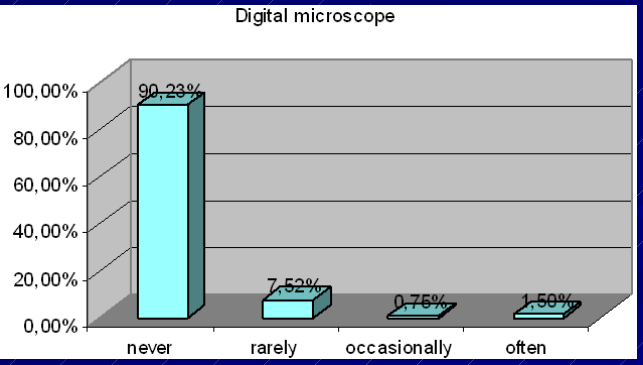

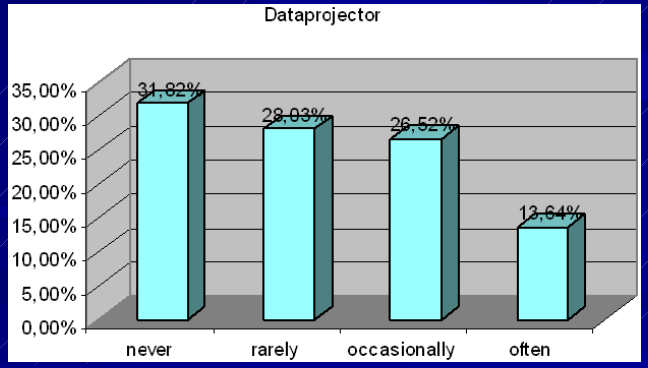

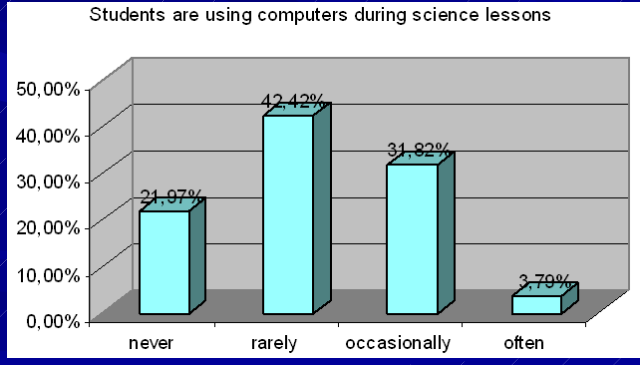

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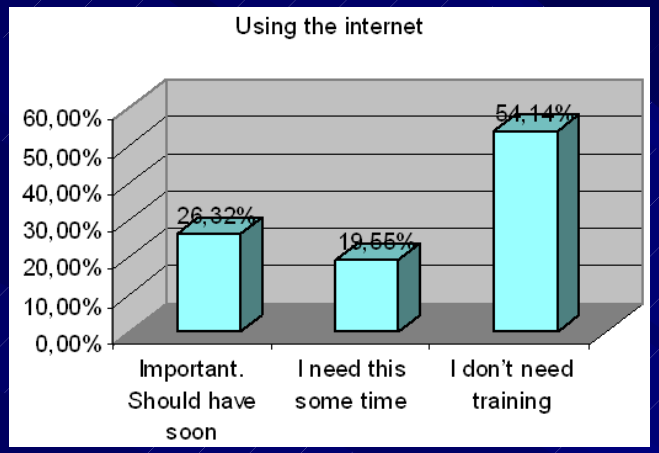
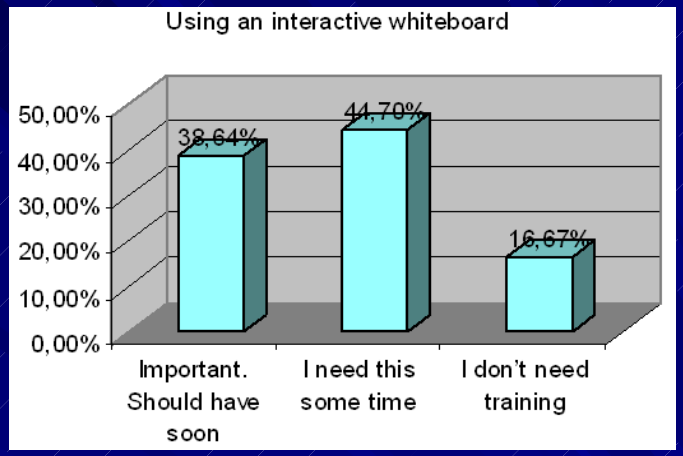
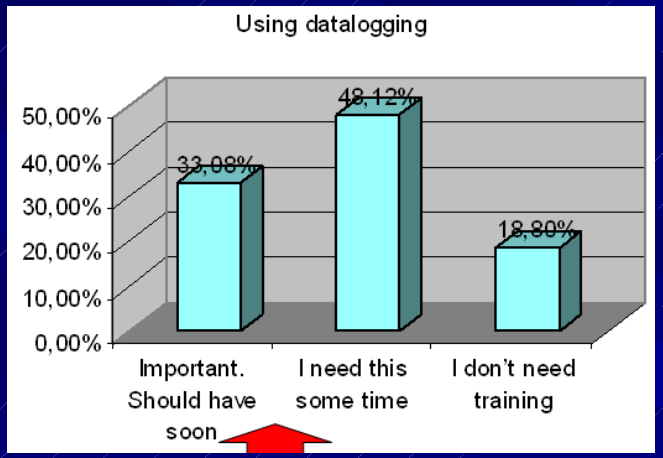
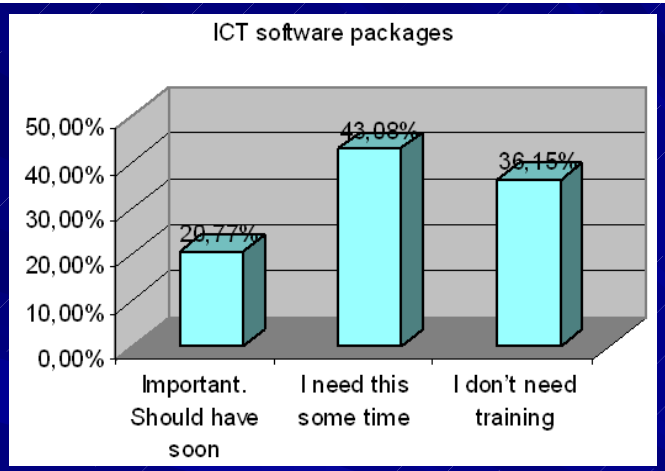
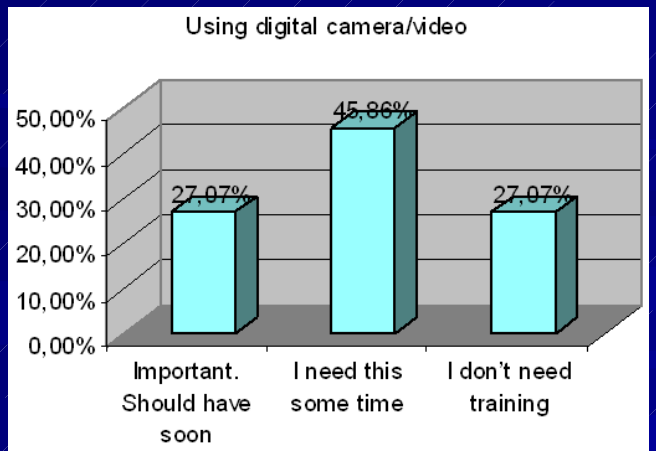
Training and development needs.

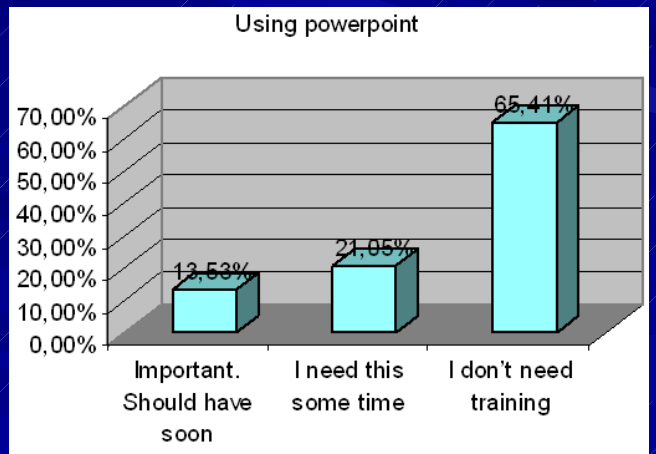












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The main advantages from the use of ICT in physics education

If the methods and tools of ICT have a good quality from the technical point of you we can try to find some general and pedagogical features, which allow us to answer the question: when, for what and how ICT should be used in science (physics) education

I. General and subject aspects

When?	For what?	How?
If the school curriculum is old fashioned or school laboratory is not sufficiently equipped	To modernise and extend knowledge and skills of students by the use of modern technology	By the use of Internet resources including virtual and distance learning
If there is necessity to exchange the ideas by students from all over the world on issues concerned with common topics	To stress some essential goals of school education, including education on important global problems	Discussion forum with the use of Internet
If the students have a lot of preconceptions and miscon-ceptions	For better (dipper) under-standing of difficult physics concepts	The use of simulations, modelling, databases, inter-active video, MBL exp., datalogging
When there is low number of hours devoted to physics teaching	To use the time of learning in much more effective way	Software designed in the way to save the time of learning
When students don't have ability to work in groups	To promote active colla-boration of students in teams	To apply different computer aided student project's work

II. Pedagogical aspects

When?	For what?	How?
When traditional methods don't offer differentiation of teaching	To adjust teaching to the individual knowledge and abilities of students	To elaborate different op-tions of work (menu options) with software
If teaching-learning process is passive	To make learning much more active	To provide interactive learning by feedback of students with software
If traditional teaching is not effective	To increase the effectiveness of teaching	To create multimedia and MBL methods using the pedagogical rules

Summary – for what ICT in science education?

- attract, arise interest, motivate students,
- increase effectiveness of work in science laboratory,
- encourage for answering the question "What will be, if…" instead performing tasks following instruction as from the recipe book,
- increase memorising and understanding of knowledge by the feedback of students with software,
- facilitate school curricula realisation due to the integration of ICT methods with the study contents,
- to provide application of multimedia methods,
- to assure apply simulation modelling and investigation of phenomena in the real time,
- assuring individual work of students allow to construct their own knowledge by creative exploration,
- cause association of computer aided work with simplifying of science understanding, as computer helps to solve ordinary as well as complicated problems,
- allow students to extend their knowledge also beyond the computer resources.

But, can we differentiate between MM methods and tools and MBL? What are the main indicators?

Multimedia	Microcomputer Based Laboratory
actualize and facilitate of the school curricula contents (with contemporary information)	actualize and facilitate of the school curricula contents (with modern info and tools)
allow to stress the most important objectives of education (goal oriented education)	allow to stress the most important objectives of education (goal oriented education)
has a potential to change ways of teaching and learning (differentiation)	has a great potential to increase the effectiveness of learning (individualization)
are based mostly on teacher centered model of learning (information, visualization,etc)	much more enable to apply student centered (interactive) model of learning
provide possibility of lessons, based on "virtual experiments" (virtual world")	secure interdisciplinary active learning from nature (with sensors, data loggers, measurement devices, data processing, elaboration and display)
facilitate the general ICT skills of students	assure development of Laboratory Based Skills (LBS)
simplify communication, stimulate interest, enthusiasm, motivation and active collaboration of students	enable active work on projects, which demand to make experiments not performed before at school level
achieve more contextual learning	provide possibility of more research oriented learning, based on constructivist idea, developing creative thinking of students
help students in their self-learning and self-evaluation	ensure Problem Based and Independent Learning

We would like to stress, that especially **MBL experiments**, together with **modeling methods** create an imaginary bridge between abstract mathematical concepts and real world and develop scientific intuition, which is the most important as a goal of science education.

Thus, about 80% of our teachers wish to be trained in these methods!

The work of teachers on MBL applications in science education

Exemplary list of exercises proposed to the Microcomputer Based Laboratory for Science Teachers

1. Mechanics experiments

- Laws of dynamics - experiments with using of the air track
- Free fall investigation – checking of the Galileo law
- Motion parameter investigations for harmonic oscillations and any other motions in gravitational field, using ultrasound, based on Doppler's effect motion detector

2. Acoustic experiments

- Acoustic oscillations and waves, computer analysis of sound
- Noise and infrasound investigations in the environment. Hearing of human exploration

3. Thermal and thermolelectric experiments

- Measurement of air humidity and thermal phenomena investigations with the use of datalogger
- Computer studies of reversible phenomena using Peltier's effect device
- Effectiveness of cooling effect with the use of based on Peltier's effect refrigerator

4. Electromagnetic, optics and nuclear physics experiments

- Checking the dependance of magnetic induction on intensity of current flowing in the coil
- The use of dataloggers in UV and IR investigations
- Investigation of copper electrosedimentation process - fractals
- Computer aided ionising radiation investigation

5. Chemical and biological experiments

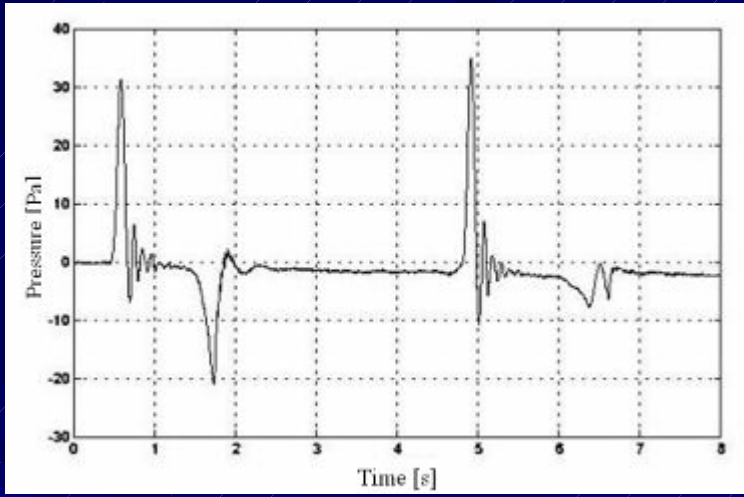
- Effect of different factors on chemical reactions rate
- Studies of milk fermentation
- Effect of some medicines on pH of gastric fluid
- Monitoring of respiration and photosynthesis processes of plants
- Acidity measurements of water
- Respiration of cricket (grasshopper)

Simulation and modelling

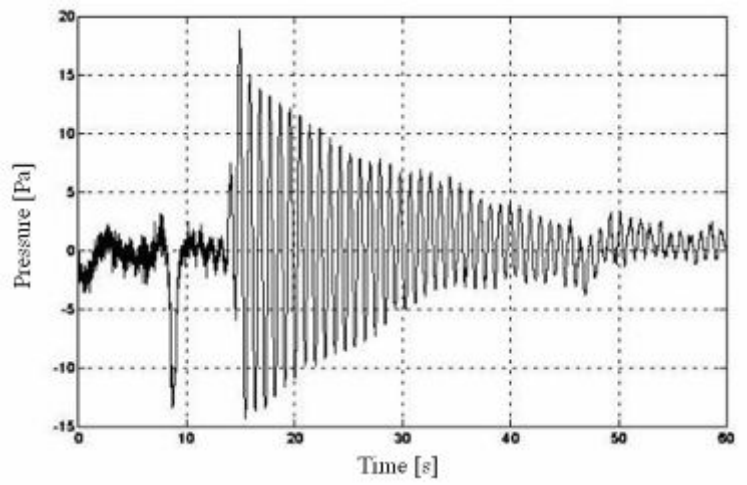
1. Brownian motion: observations, computer simulations, interactive video method
2. Thermodynamics phenomena: ideal gas – transformations, internal energy, I thermodynamics principle
3. Radioactive decay

Infralogger – infrasound detector

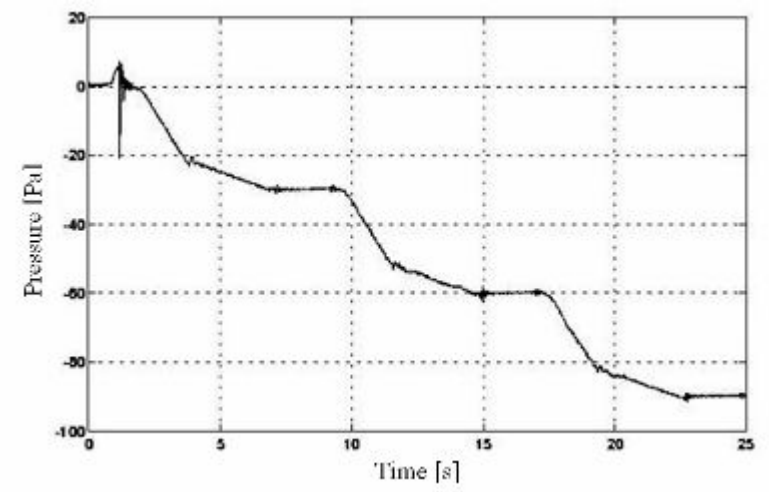
In 2000 in the Institute of Physics NCU we have constructed special computer aided device for investigation of infrasound (in the range 20Hz-0,01Hz). Computer software for registration of sound signals, which can be analysed with the programmes Cool Edit, Goldwave, Origin. Having such device to the disposal we can detect and register sounds, which we don't hear, but they are danger. We would like to add, that infrasounds can't be detected by the ordinary microphone.



Perturbation of pressure in the room caused by opening the window (two times)



Perturbation of pressure in the tunnel caused by the car motion



Perturbation of pressure in the moving up elevator

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Ecological refrigerator

Model of a smart refrigerator for environmental education

In this experiment we would like to emphasise the educational value of experiments using the Seebeck-Peltier's semiconductor junctions. For this purpose we constructed the working model of the heat pump consisting of the two commercially available Peltier's batteries connected in a cascade. With this device one can demonstrate heating with the efficiency greater than 100%, cooling without ecologically undesirable noise and freons as well as the reversibility of the observed phenomena. It can be used as a refrigerator or heater by simply changing the direction of electric current, but at the same time it can also generate electric current if we keep junctions at different temperatures.

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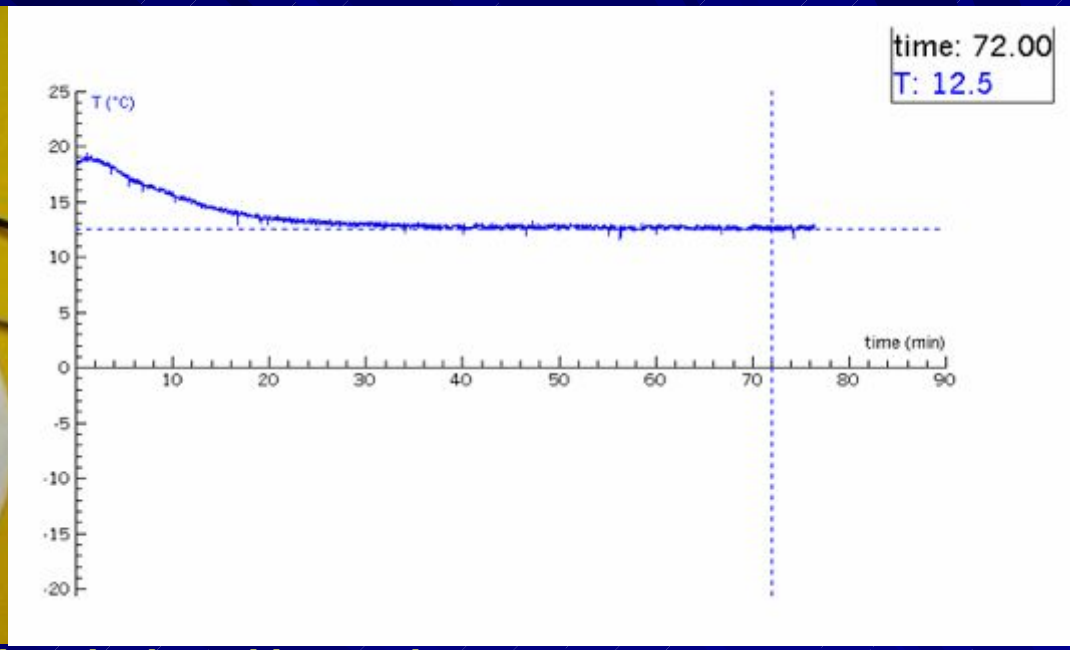
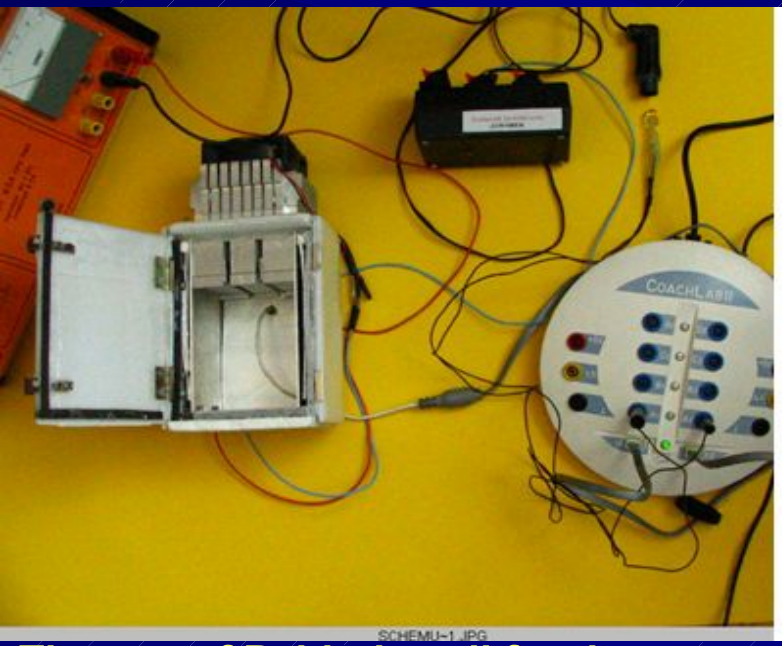
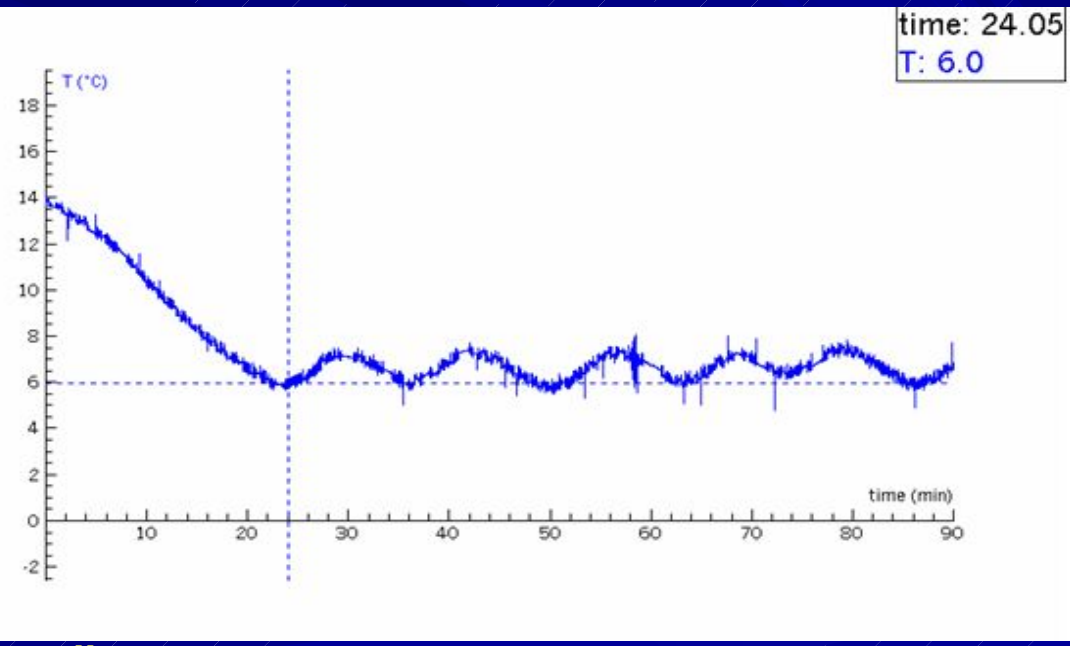


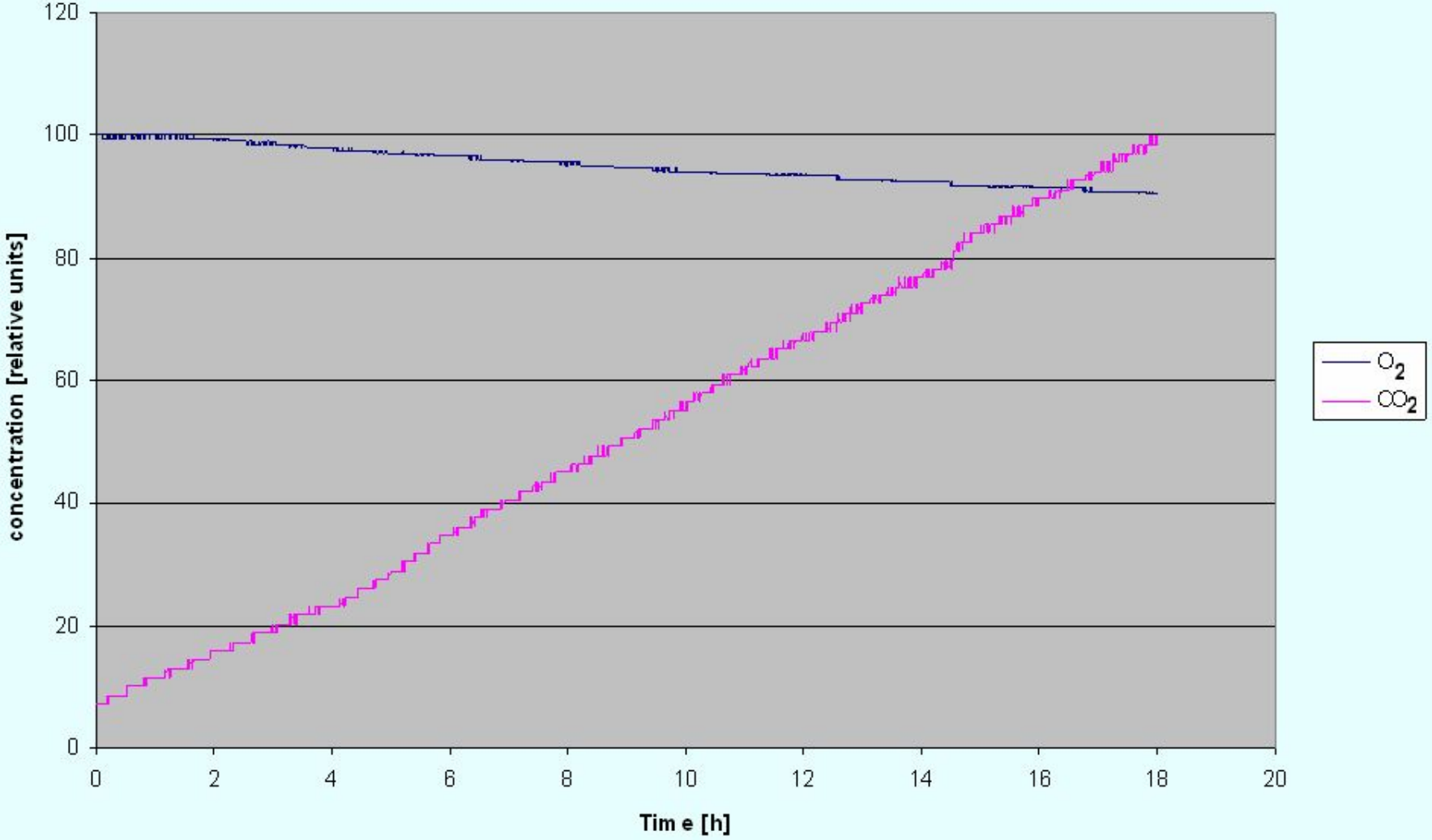
The use of Peltier's cell for thermos cooling designed by students



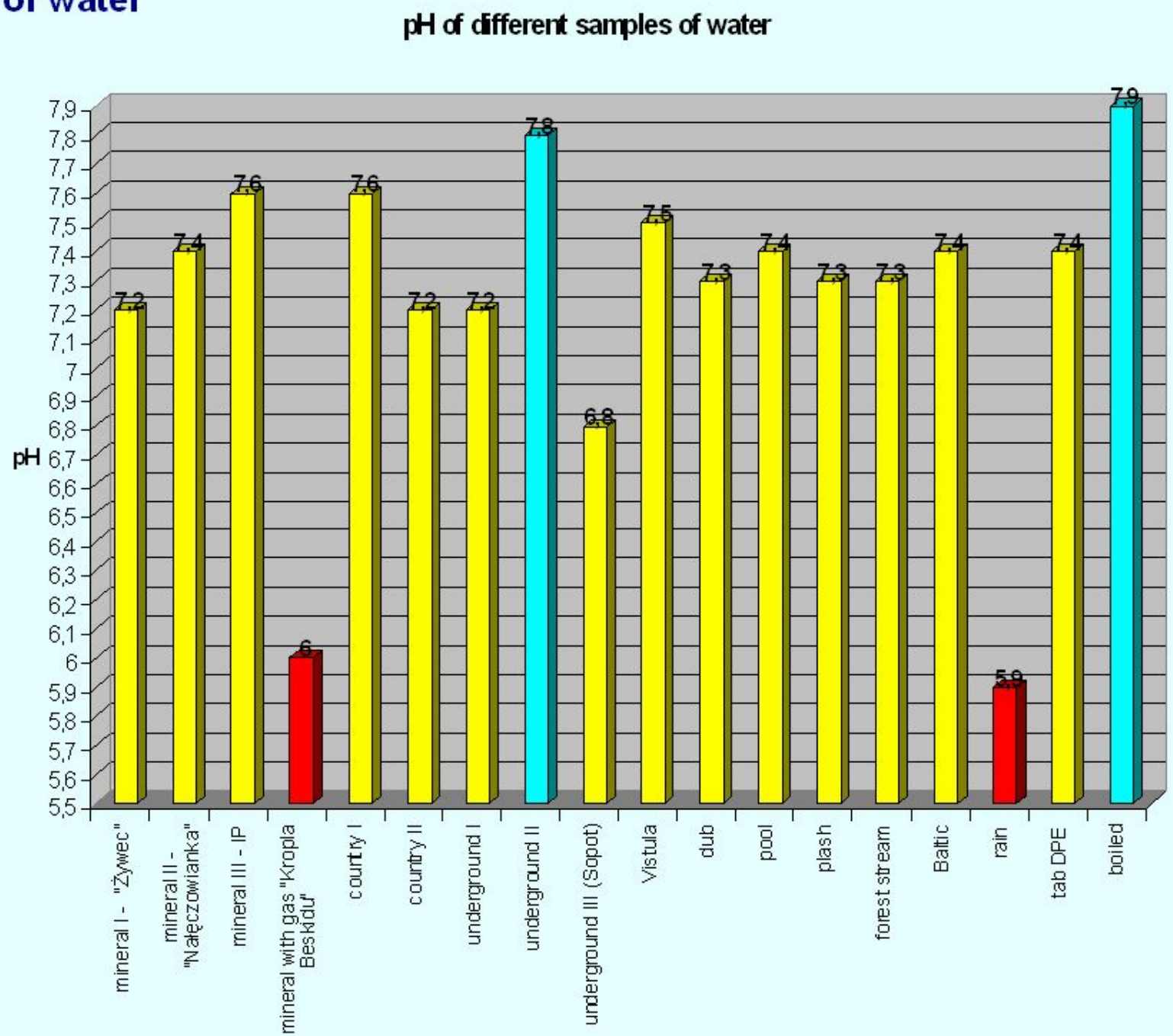


The use of Peltier's cell for thermostatic cooling

Respiration of grasshopper



Quality of water



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Thank You for Your Attention!

Dydaktyki fizyki

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